

**Nurturing**  
the next generation of  
**scientists,**  
**engineers** and  
**mathematicians!**

In collaboration with:



# STEM THEMATIC PROJECT

- Problem-solving Skills
- Investigation
- Collaboration
- Knowledge Application
- Engineering Literacy
- Refinement

## Projects for Primary Schools

**STEM THEMATIC PROJECT** Infused with PICKER elements

### Smart Racing Car



A collaboration between:  
 Marshall Cavendish Education  
 Singapore



**STEM THEMATIC PROJECT** Infused with PICKER elements

### Roman Catapult

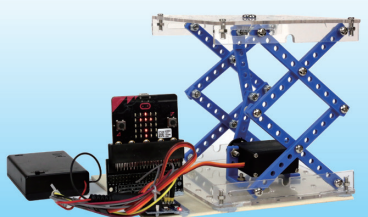




A collaboration between:  
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 Singapore




**STEM THEMATIC PROJECT** Infused with PICKER elements

### Electric Elevator



A collaboration between:  
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### Magnetic Levitation Train



A collaboration between:  
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 Singapore



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### Aeronautics Technology

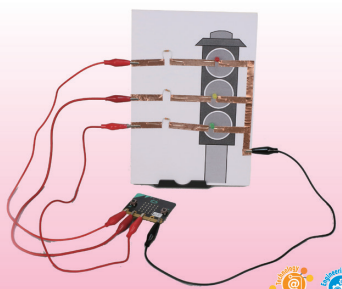




A collaboration between:  
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 Singapore




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### Traffic Lights Control System



A collaboration between:  
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 Singapore






Marshall Cavendish Education works closely with Science Centre Singapore to develop high quality and up-to-date solutions with authentic tasks for primary and secondary STEM curriculums.




**The STEM Thematic Project** places emphasis on the application of Science, Information and Communication Technology, Engineering and Mathematical knowledge. Through these projects, students cultivate essential 21st Century competencies and learn to appreciate the impact of science in everyday life.

## Projects for Secondary schools

**STEM THEMATIC PROJECT** Infused with PICKER elements

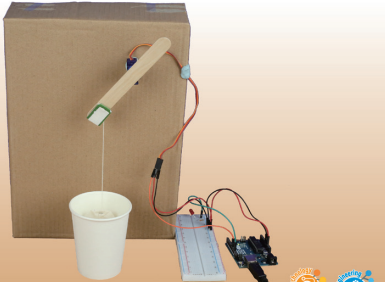
### Making a Drone

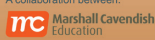




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### Making an Automated Tea Brewer





A collaboration between:  
  

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### Smart Fitness Station



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### Coding Your Game






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### Wearable Electronics



A collaboration between:  
  

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### 2WD Car (Arduino)



A collaboration between:  
  

**STEM Thematic Project** provides a bank of resources and support for teachers to use. They have been divided into primary and secondary resources, based on the demands of the Singapore curriculum. However, the kits can be used interchangeably between Key stage 3 (primary) and Key Stage 4 (secondary) depending on the student's individual needs.

# Primary Schools

## STEM THEMATIC PROJECT

### 1 *Magnetic Levitation Train*

A few countries use high-speed 'maglev' trains that 'float' over tracks. How is this possible?

#### SCIENCE

Properties of a magnet; Connecting a closed circuit; Effects of friction on the movement of an object; Structure and principle of a magnetic levitation train

#### TECHNOLOGY

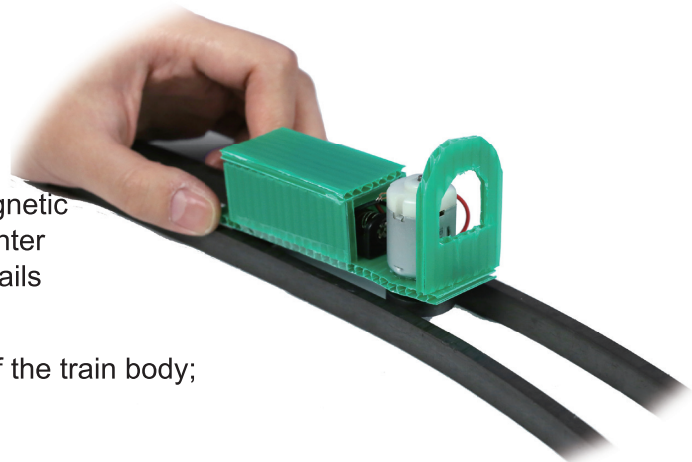
Use 3D design software to design a magnetic levitation train and its rails; Use a 3D printer to make a magnetic levitation train and rails

#### ENGINEERING

Choosing materials for the 3D printing of the train body; Design and refinement of product

#### MATHEMATICS

Parallel lines; Calculation of speed



### 2 *Roman Catapult*

In ancient times a catapult could launch a projectile over a large distance without the need for explosives. What is the science behind this powerful tool?

#### SCIENCE

Principle and different types of levers; Energy conversion; Structure and working principle of a Roman catapult

#### TECHNOLOGY

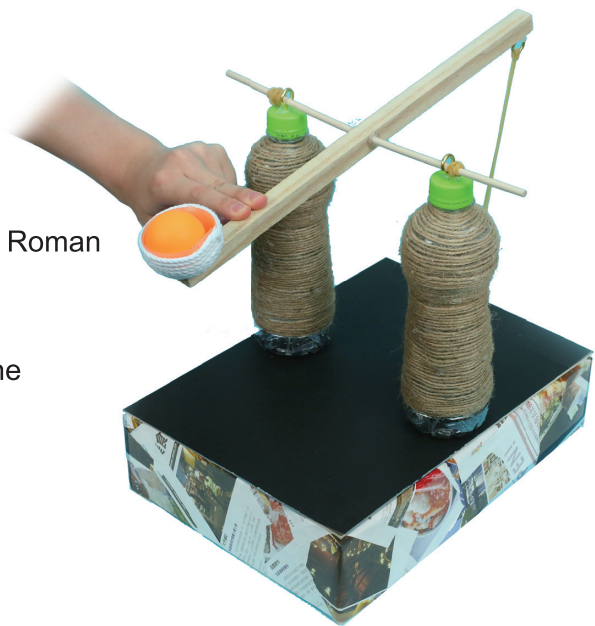
Use 3D design software to draw the design of the catapult.

#### ENGINEERING

Design and refinement of product

#### MATHEMATICS

Percentages; Average of a group of data



3

## Aeronautics Technology

Most people think a rocket is something that launches into space. It can mean an engine or the vehicle itself. But how does a rocket engine work?

### SCIENCE

Structure and working principle of a water rocket; Action and reaction forces

### TECHNOLOGY

Use 3D design software to design the fins of the fins of the water rocket;

### ENGINEERING

Design and refinement of product

### MATHEMATICS

Measure and compare the capacities of containers; Choose the appropriate tools for measurement; Fractions; Measure and compare the sizes of angles



4

## Electric Elevator



An elevator or lift transports people vertically between floors of a building. This can save time and energy by not taking the stairs. How can you create an automatic one?.

### SCIENCE

Energy conversion; Basic mechanics; Reflection of light (IR sensor)

### TECHNOLOGY

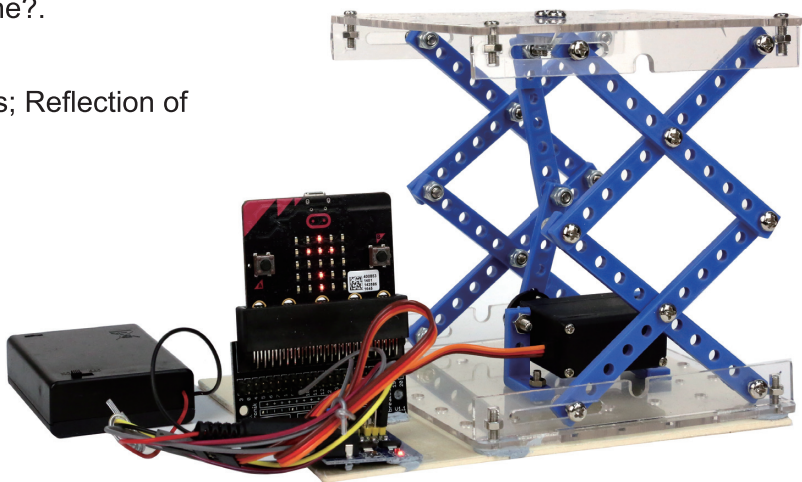
Coding of micro:bit; Use of sensors

### ENGINEERING

Design and refinement of product

### MATHEMATICS

Calculation of angle movement of servo motor



# Primary Schools STEM THEMATIC PROJECT

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## Traffic Light Control System



Traffic lights are signalling devices found at road intersections and pedestrian crossings and are used to control flows of traffic. How do they know when to change colour?

### SCIENCE

Completion of circuit; Telecommunications

### TECHNOLOGY

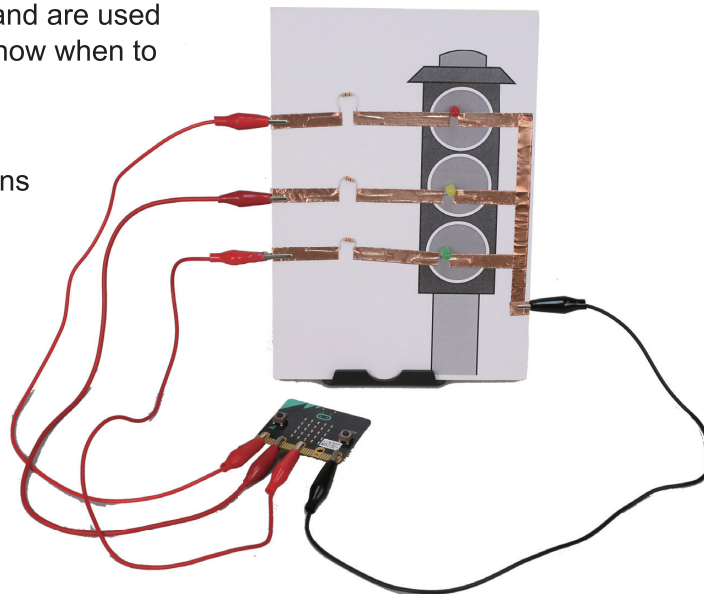
Coding of micro:bit; Use of sensors

### ENGINEERING

Design a signal system

### MATHEMATICS

Calculation of time interval; Sequence



6

## Smart Racing Car



A radio-controlled car is steerable without the use of a driver. How can we control the speed and direction of a robotic car without pushing it?

### SCIENCE

Energy conversion;  
Telecommunications

### TECHNOLOGY

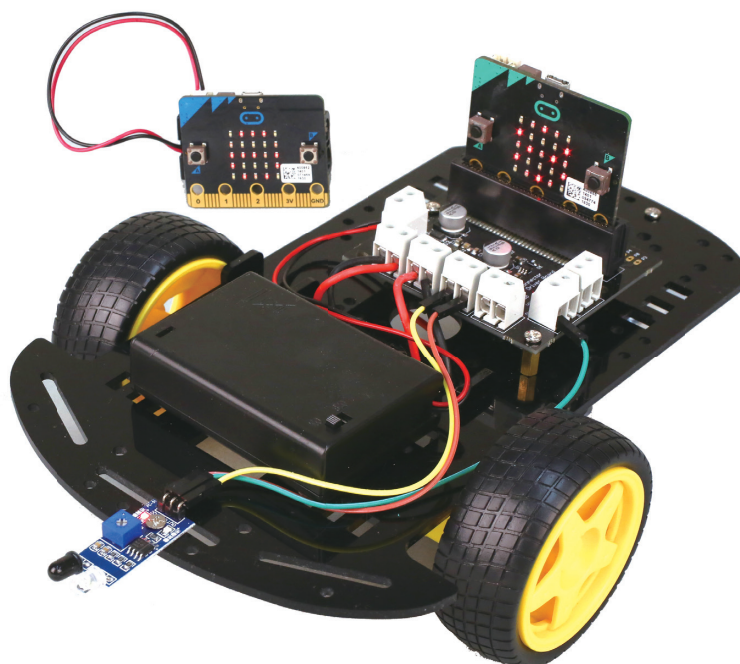
Coding of micro:bit; Use of sensors;  
Wireless communication

### ENGINEERING

Design and refinement of product

### MATHEMATICS

Calculation of speed and distance  
travelled



# Secondary Schools

## STEM THEMATIC PROJECT

### 1 Making an Automated Tea Brewer



Tea is the second most consumed drink in the world, surpassed only by water. A surprising fact is that all teas (Black, Green and Oolong) come from the same plant. How can we make the perfect cup of tea?

#### SCIENCE

Diffusion of substance; Concentration; Basic mechanics

#### TECHNOLOGY

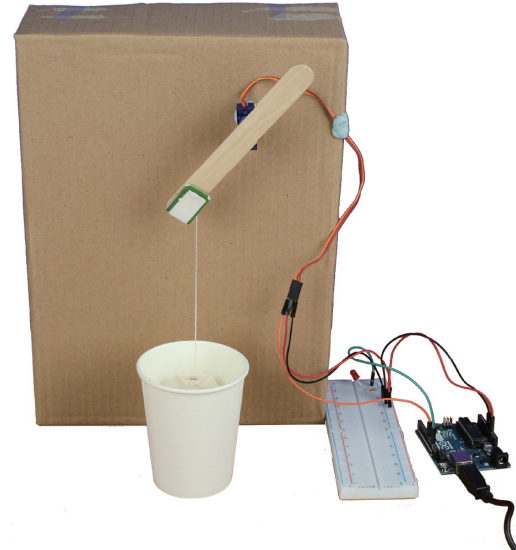
Coding of Arduino; Use of light sensors

#### ENGINEERING

Design and refinement of product

#### MATHEMATICS

Data sampling; Drawing of graphs



### 2 Smart Fitness Station



Fitbits are devices that track a person's activity level and help people to workout effectively. How do they sense the change in heart rate and monitor health?

#### SCIENCE

Human anatomy and physiology; relationship between heart rate and exercise, pulse

#### TECHNOLOGY

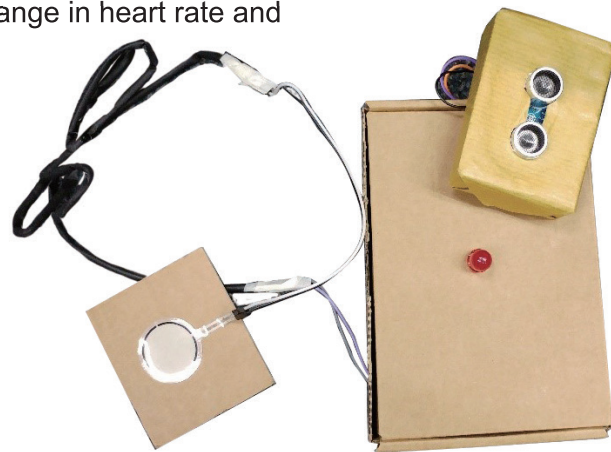
Use Arduino and C/C++ coding; use of a variety of sensors and actuators; working principles behind electronic components; use heart rate app

#### ENGINEERING

Design of products that take into account the type of exercise, the range of movement, the efficiency and accuracy of completing the motion; refinement of product

#### MATHEMATICS

Calculation and monitoring of heart rate, making comparison of heart rate with the target heart rate



## Secondary Schools

# STEM THEMATIC PROJECT

### 3 Coding Your Game

The world is filled with computer games and social media. Most of us know how to use these technologies but do we understand the logic behind them? How can we learn the 'magic' behind the technology and also encourage innovation?

#### SCIENCE

Fundamental computer science concepts such as "forever loop"; Applying knowledge to make realistic, immersive games that mimic reality

#### TECHNOLOGY

Use Scratch software to code and programme a game while learning computational thinking; Differences between image formats for use in games;

#### ENGINEERING

Application of knowledge can produce games that simulate reality and produce valuable data

#### MATHEMATICS

Graphs; creation of variables; changing of values and their associated outcomes (i.e. speed, size and shape)



### 4 Wearable Electronics



Wearable technology or fashion electronics are devices that can be worn on the body as clothes or accessories. How can we brighten up our lives by using these gadgets?

#### SCIENCE

Basic human health; basic human anatomy and physiology; basic bio-mechanics; the Red, Green and Blue colour model

#### TECHNOLOGY

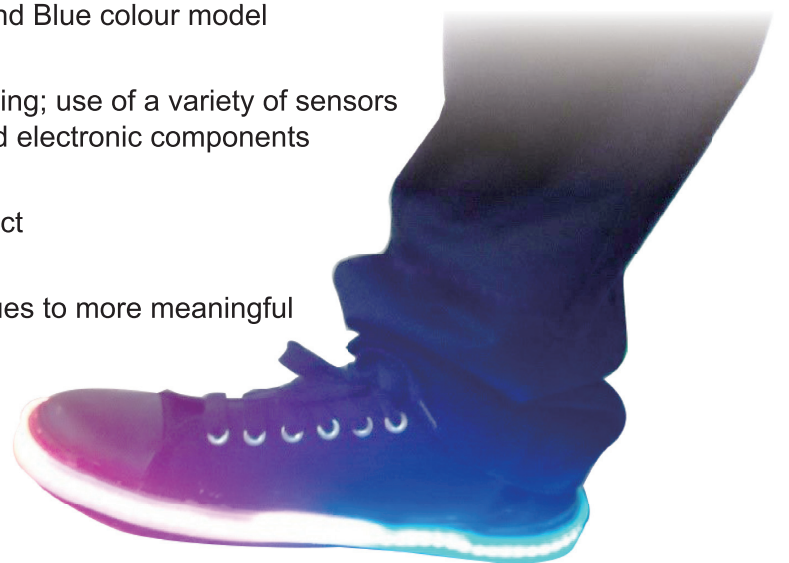
Use of micro-controllers and C/C++ coding; use of a variety of sensors and actuators; working principles behind electronic components

#### ENGINEERING

Design of products; refinement of product

#### MATHEMATICS

Data sampling; translation of digital values to more meaningful data; RGB values; variables





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## 2WD Car (Arduino)



A radio-controlled car is more than a toy. It is also an educational tool that can help students develop critical skills; learn responsibility, improve the development of hand-eye coordination and enhances fine motor skills. What other benefits can we gain from making a toy car?

### SCIENCE

Connecting a closed circuit; Effects of friction on the movement of an object; energy conversion

### TECHNOLOGY

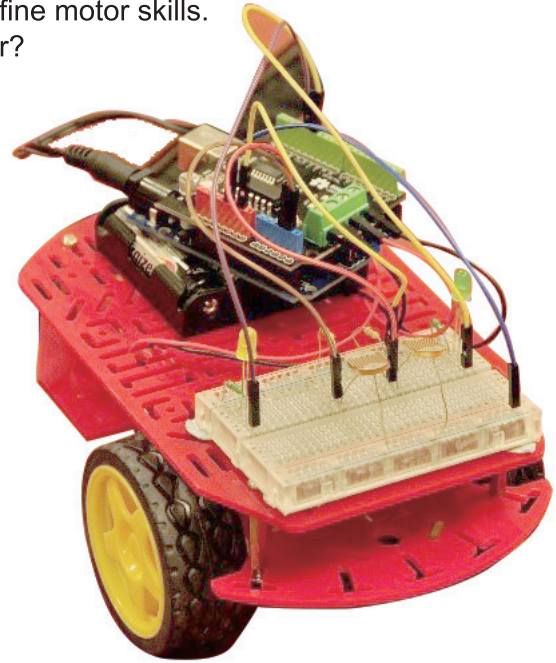
Use micro-controllers, C/C++ coding, electronic components and shields

### ENGINEERING

Design and refinement of the product; assembly and troubleshooting of the car

### MATHEMATICS

Turning angles; differential drive; calculation of speed; motor efficiency



6

## Making a Drone



Drones are unmanned aircrafts that can be navigated without a human pilot on board. Some of these drones are equipped with cameras that allow the user to record and take pictures or used in situations too dangerous for humans. How can we learn to fly without leaving the ground?

### SCIENCE

Principles of flight; material science; aerodynamics; centre of gravity; forces; gyroscopic torque

### TECHNOLOGY

Use micro-controllers and coding; use of a variety of materials, sensors, motors and other effectors; use of 3D printer; working principles behind electronic components

### ENGINEERING

Use and testing of a variety of materials; choosing materials for the drone chassis; engineering efficient design for flight

### MATHEMATICS

Effect of propeller parameters on flight; effect of motor efficiency and power; calculation of flight paths; calculation of flight times



# STEM

## Curriculum Design, Consultation and Training Services

STEM Thematic Project advisory committee was set up in early 2016, it comprises of leading academic professors and practitioners in science, mathematics and technology education. The committee plays an active role in steering the development of our STEM Thematic Project curriculum and professional development programmes. They also form the basis of our consultancy work, which includes the promotion, planning, and implementation of strategies, to achieve an integrated and effective STEM education.

**2 Making the magnetic levitation train**

**Equipment and materials**

Circular magnet	2
Corrugated plastic sheet	1
Screw cap	1
Screw	1
Metal ring	1
Motor	1
Linkage rod	1
Battery case and wire	1
AA Battery	1
Puncher (sharpened pencil)	1
Pair of Scissors	1

Materials Lists

**Extended Learning**

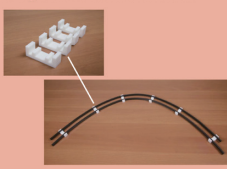
Using 3D Printing

Other than corrugated plastic sheets, we can also use 3D drawing software and a 3D printer to make the 'magnetic levitation train' and its rails.

**1 Making the rails of the 'magnetic levitation train'**

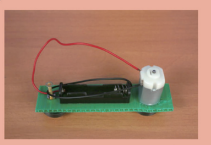
**Guidelines**

Produce a number of bases using 3D drawing software and a 3D printer. Fit the two soft bar magnets to the bases and form the rails of the train.



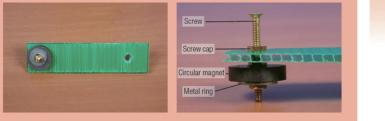
Supplementary Information

6. Fix a battery case in the middle of the upper side of the train body with double-sided adhesive tape. Connect the wire of the battery case to the motor.



Teaching Tip: Before the battery case is connected to the motor, remove the rubber casing at the end of both the red and black wires, exposing 1 cm of the copper wire inside. The red wire is connected to the positive pole and the black wire to the negative pole.

Teaching Tips



Teaching Tips:

(a) Place the circular magnet on the rails again before attaching it to the train body to make sure that the pole facing down is opposite to that of the inner side of the rails.

(b) Three screw caps are needed when making the rear wheel of the train.

**Flipped Classroom**

**Determining parallel lines**

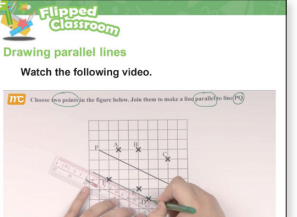
The teacher will give a worksheet to you. Using the method in the video, determine whether the sets of straight lines are parallel. When you finish, circle the answers and take a photo.

Powerpoint Presentations

**Flipped Classroom**

**Drawing parallel lines**

Watch the following video.



Lesson Plans

**Teacher's Guide — Part 2**

Qualities of Teaching Activity	Duration	Teaching Resources
<p><b>A. Background Information</b></p> <p>(1) <b>Understand the properties of a magnet</b></p> <ul style="list-style-type: none"> <li>Identify poles and repulsion/attraction.</li> <li>Teachers can distribute bar magnets with known poles to students and ask them to see the repulsion/attraction between the magnets poles to identify the poles of the magnets.</li> <li>Ask students to think about a steel that uses the property of magnetism.</li> </ul> <p>(2) <b>Understand the properties of a compass</b></p> <ul style="list-style-type: none"> <li>Teachers can distribute compasses to students and introduce the function of a compass.</li> <li>Teachers can provide the magnetic class of magnets to students. When they provide a piece of iron/steel magnet, they provide information about the use/poles of the magnets. <a href="http://www.ck12.org/physics/properties-of-magnets/">www.ck12.org/physics/properties-of-magnets/</a></li> </ul>	<p>Level 1: 35 minutes</p>	<ul style="list-style-type: none"> <li>Teaching PowerPoint</li> <li>Bar magnets with known poles</li> <li>Compass</li> </ul>

**Teacher's Guide — Part 1**

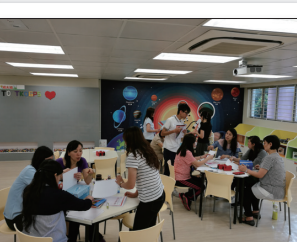
STEM Program	Magnetic Levitation Train
<b>Level</b>	Elementary
<b>Learning Elements</b>	<p><b>Content</b></p> <ul style="list-style-type: none"> <li>Understand the properties of a magnet</li> <li>Learn how to connect a closed circuit</li> <li>Understand the effect of friction on the movement of an object</li> <li>Understand the principle of how a magnetic levitation train works</li> </ul> <p><b>Process</b></p> <ul style="list-style-type: none"> <li>Use 3D drawing software to draw the design of a magnetic levitation train and rails</li> <li>Use a 3D printer to make a magnetic levitation train and rails</li> </ul> <p><b>Math</b></p> <ul style="list-style-type: none"> <li>Recognize parallel lines</li> <li>Understand the concept of speed</li> <li>Solve simple problems</li> </ul> <p><b>Knowledge</b></p> <ul style="list-style-type: none"> <li>Understand the property of attraction and repulsion between magnets</li> <li>Understand the components of a closed circuit</li> <li>Understand the principle of how a magnetic levitation train works</li> <li>Understand what factors affect the speed of the 'magnetic levitation train'</li> </ul> <p><b>Learning Objectives</b></p> <p><b>Skills</b></p> <ul style="list-style-type: none"> <li>Use appropriate materials and tools to make a 'magnetic levitation train' and its rails</li> <li>Use an appropriate formula to calculate the speed of a 'magnetic levitation train'</li> <li>Collect data by conducting experiments to improve the design of a 'magnetic levitation train'</li> <li>Analyse the problems that come up during the operation of a 'magnetic levitation train' and make improvements</li> </ul>

**Demonstration video**

**Magnetic Levitation Train**




Demonstration Videos



At Marshall Cavendish Education, we believe that high-quality educational content is vital for ensuring effective teaching and learning. We strive to empower lives by transmitting knowledge, processes, and skills through providing unique educational solutions, and we have been doing so for more than 60 years.

Our materials are research-based, and our authors are subject experts and experienced educators. Our insistence on quality has enabled our materials to be approved by the Singapore Ministry of Education since the 1980s. Over the years, our materials have also gained international recognition and are now used in over 60 countries.

Headquartered in Singapore, we have offices in Thailand, Hong Kong, China, Chile, the United Kingdom and the United States of America.



singapore

The Science Centre Singapore is dedicated to the promotion of science and technology among students and members of the public. As a leading Science Centre in the region, it has twelve exhibition galleries with more than 1,000 interactive exhibits.

Science Centre Singapore is moving towards actively promoting STEM education through several STEM-related initiatives. These include workshops, lesson materials and exhibits.

- Ignite students' passion for Science, Technology, Engineering and Mathematics (STEM) so as to inspire them to take up STEM-related courses.
- Raise students' aspirations in pursuing STEM careers by exposing them to the real-world applications, problems and industries.
- Uplift professional STEM career images.

**Collaboration**

**STEM**

**Innovation**



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